Fuel Cells

S&T Campaign: Materials Research
Energy & Power
Fuel Cells

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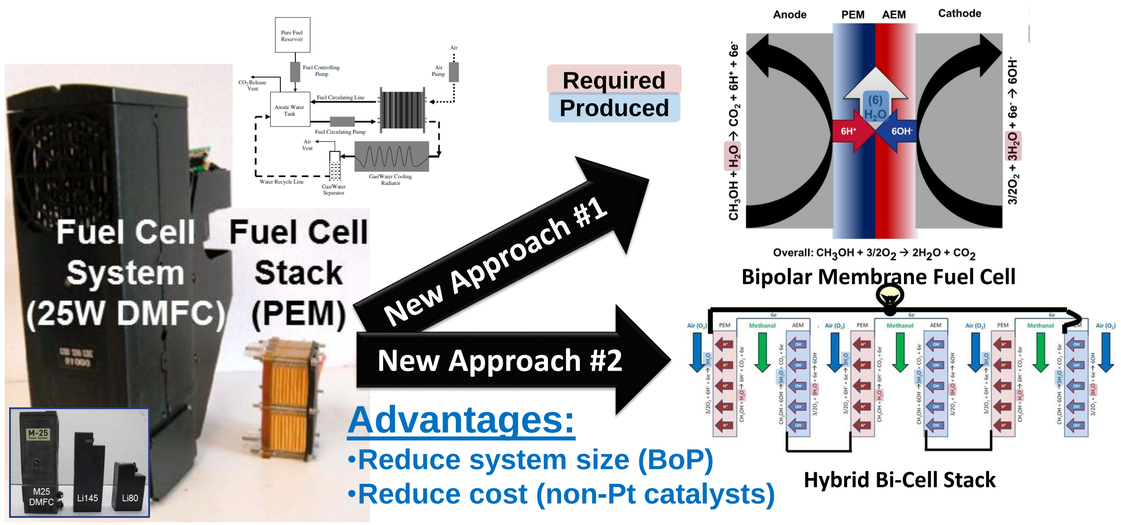
Research Objective

- **Provide light, compact, cost effective, and energy dense power sources which can unburden the Solider and reduce logistics requirements.**
- **Our specific approach seeks to develop novel and highly ionic conductive and stable alkaline- and acid-alkaline hybrid membrane materials and interfaces for Soldier wearable and portable fuel cell power sources.**



Advantages:
- Reduce system size (BoP)
- Reduce cost (non-Pt catalysts)

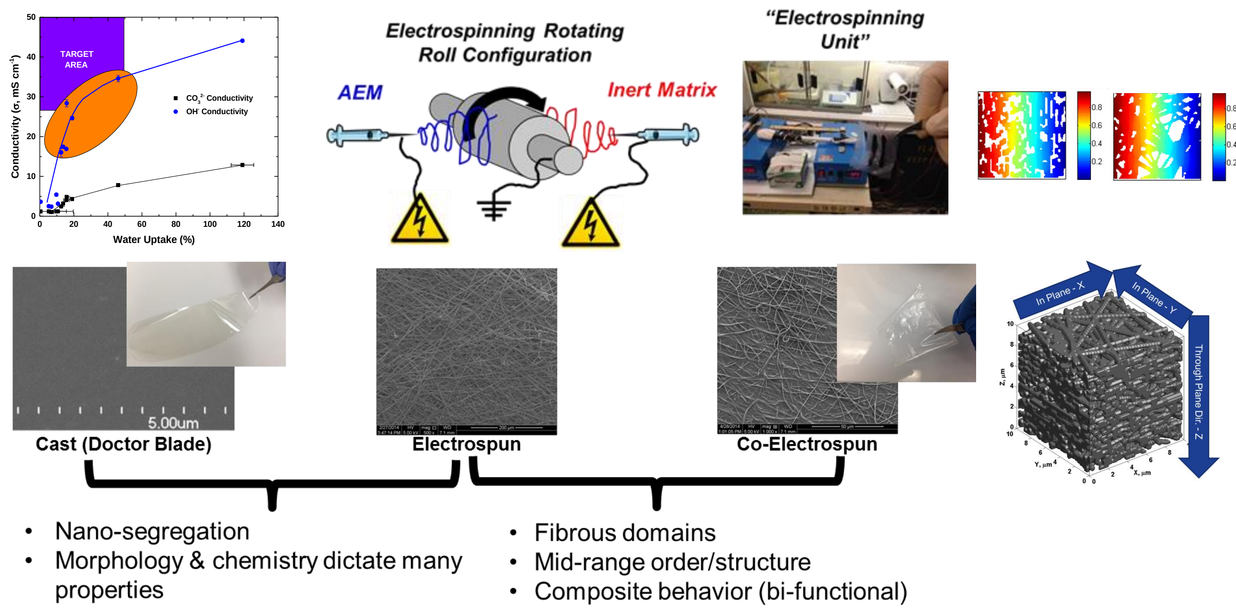
Size of the state of the art Direct Methanol Fuel Cell (DMFC) System, which utilizes acidic Nafion electrolyte materials, is largely attributed to Balance of Plant (BoP) for fuel, water & thermal management. Our proposed approach(es) to address size & cost via the use of hybrid acid- & alkaline-membrane configurations.

Challenges

- **Producing mechanically, chemically and thermally stable anion exchange membranes (AEM) and ionomers tolerant to alcohol environments.**
- **Understanding transport and degradation mechanisms/pathways and mitigating.**
- **Repeatable and scalable materials synthesis and processing routes.**
- **Development of highly active and stable catalysts/support/ionomer dispersions employing non-platinum catalyst for the fuel cell electrodes.**
- **Understanding and manipulating fuel and oxygen permeation in ionomer materaisl/dispersions.**
- **Mitigation of penalties and effects from ambient and produced carbon dioxide (i.e., from air and methanol oxidation processes, respectively).**
- **Developing and understanding interfacial phenomena associated with three-phase interfaces and acid-alkaline membrane interface.**
- **Highly active and selective non-platinum group metal (non-PGM) electrocatalysts.**

ARL Facilities and Capabilities Available to Support Collaborative Research

- **Full suite of equipment for electrochemical characterization and fuel cell testing.**
- **Environmental chambers, dry rooms, and glove-box access for characterizations and/or synthesis/processing steps requiring specialized environmental conditions and controls.**
- **Electrochemical in-situ AFM and Raman-AFM.**
- **Standard materials characterization suites (BET, XRD, XPS, SEM, etc.).**
- **Lab-scale polymer electrospinning**
- **Department of Defense (DoD) High Performance Computing (HPC) Center computational resources.**



Processing approaches being considered to producing unique membrane morphologies & structure-property relationships.

Complementary Expertise / Facilities / Capabilities Sought in Collaboration

- **Morphological and mechanical materials characterizations (e.g., SAXS, Neutron scattering, environmental-instron, etc.).**
- **Chemical and transport characterization capabilities (e.g., NMR, pulse-gradient & dielectric relaxation methodologies)**
- **Capabilities to synthesize advanced polymer chemistries to include fluorinated, crosslinked, and multi-block polymers of specific configuration(s).**
- **Predictive modeling & simulation efforts geared toward understanding materials synthesis and processing; morphology; structure-property relationships; transport; and stability.**

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